Express Mail Mailing Label No.: EL653444501US

PATENT
Attorney Docket No. BSC-010C2

Particulars of prior application:

Serial No.: 09/478,774
Filing Date: January 6, 2000
Examiner: Ruth Smith of Art Unit 3737

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Crowley, R.		
SERIAL NO.:	Not yet assigned.	GROUP NO.:	Not yet assigned.
FILING DATE:	Herewith.	EXAMINER:	Not yet assigned.
TITLE:	MINIATURE SPECTROMETER		

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

Kindly enter the following preliminary amendment after assigning a filing date but before beginning examination of the patent application identified above. A continuation of U.S.S.N. 09/478,774 is filed herewith.

In the Specification:

On page 1, please delete the section "Cross-Reference to Related Application" and replace with the following:

Cross-Reference to Related Application

This application is a continuation of U.S. Patent Application Serial No. 09/478,774 filed January 6, 2001, which is a continuation application of U.S.

Patent Application Serial 08/898,604 filed July 22, 1997, now U.S. Patent No. 6,119,031 which is based on U.S. provisional application serial no. 60/033,334 filed November 21, 1996. The entire disclosure of these applications are incorporated herein by reference.

On pages 6 and 7, please delete the paragraph bridging pages 6 and 7, and replace with the following paragraph:

Referring now to FIG. 1B, the alternative signal processing system includes a centering scale meter 33 driven by a DC source 34 placed in the common return line 38 extending from the light detector 5. This alternative signal processing system may be used to observe the different signal amplitudes of optical signals received by two or more channels of the light detector 5 operating simultaneously, or the normalized output of the light source versus the light energy received by the light detector 5. The amplitude of the reading may be used to determine the slope of the response signal relative to the input signal or to perform other more complex functions. It should be understood at this point that an equivalent operation may be obtained using a single channel light detector as long as a response property of the channel is varied over time. It may be possible to vary the response property by using, for example, one or more filters. In the case of a single channel light detector, the two signals may be obtained sequentially, if desired. The functions provided by the above-described circuitry may be achieved with other or additional electrical, mechanical, and/or optical apparatus without departing from the spirit and scope of the invention.

On pages 7 and 8, please delete the paragraph bridging pages 7 and 8, and replace with the following paragraph:

The spectrometer module 41 includes a light source 3, two light detectors 61, a lens 47, a light amplifier 49, and a window 55. The light source 3 is a semiconductor diode source, mounted such that the output end 45 is facing the distal end of the module 41, which is generally in line with the central axis of the interventional device 4. Alternatively, the light source 3 may be positioned such that the output end faces a direction transverse to the center axis of the interventional device 4. Light generated by the light source 3 may directly illuminate a tissue region or may be focused by a lens 47 before illuminating the tissue region. The lens 47 may be shaped to focus the light into a desired pattern, or may be used to diffuse the light if needed. A frequency multiplier 49 is placed in the path of light generated by the light source 3 to amplify the frequency of the light output. The frequency multiplier 49 comprises an optically nonlinear substance. The optically nonlinear substance 49 is held in position with a ring holder 51, to maintain its position with respect to the position of the light source 3. Alternatively, the nonlinear substance 49 may be bonded directly to the output end 45 of the light source 3 using an optically clear bonding material. The optically clear bonding material may be epoxy, cyanoacrylate, or sodium silicate. The bonding material may be placed directly upon the output end 45 of the light source 3 and its surrounding area, and the nonlinear substance 49 may be placed upon the bonding material. An example of an optically nonlinear substance suitable for use with a spectrometer module of the invention is a potassium dihydrogen phosphate (KH_2PO_4) or KDP crystal. In order to improve light transmission, at least one surface of the KDP crystal may be coated with a fluoride layer that acts as a one-quarter wave matching layer 53. A window 55 is placed at the distal end of the spectrometer module 41 to protect the module. The window 55 may be held in place by bonding the window 55 to the distal tip of the interventional device with an adhesive 57. In a preferred embodiment, the

window 55 includes a bandstop filter characteristic that attenuates output frequencies of the light generated by the light source 3 while permitting passage of light output having a predetermined frequency. Light output permitted to pass through the filter is often in the ultraviolet range, and particularly has wavelengths from about 300 nm to about 400 nm. Such filters are generally available and known. Examples of these types of filters include tinted glass, sandwiched dyes, and interference filters otherwise known as dichroic filters. Alternatively, variable filtration may be employed by rotating the inner portion of the module 41 relative to portions of another colored material, such as a tinted plastic catheter sheath or a tip 81 shown in FIG. 4. The catheter sheath or the tip 81 may have differing filter characteristics owing to changes in thickness, or due to localized dyes.

On pages 9 and 10, please delete the paragraph bridging pages 9 and 10, and replace with the following paragraph:

Referring to FIG. 3, the spectrometer module 41 of FIG. 2A is disposed at the distal end of an interventional device 70. In the disclosed embodiment, the module 41 is attached to the distal end of a shaft 71, and the shaft 71 houses signal wires 9, 10, and 13. The shaft 71 terminates with a small connector 73 at the proximal end. The connector 73 may have one or more contacts arranged to permit electrical, optical, and mechanical connection to a mating connector. The shaft 71 also has a slidable stop 75 that may be prepositioned to allow control of the depth of placement within the body. The stop may be a collar with a collet ring 77 that tightens when twisted to provide a positive stop. The shaft 71 may comprise a tube, such as stainless steel hypo tube, superelastic (nitinol) tube, or the like. The advantage of such shafts is that they are relatively rigid and allow insertion into partly occluded passages. Very small shafts may be made with metal tubes. Shafts having outside diameters of about 0.005 inches may be provided, although in most instances, larger shafts with diameters of about 0.08 inches or larger are adequate. Lengths of the shafts may also vary between a few

millimeters to over 200 centimeters. The shaft 71 may be made of a more flexible material if desired. Multi-layered counterwound wires of small diameter may be used as the shaft material. These shafts have relatively high lateral flexibility and good torsional stiffness, and can be positioned to specific angles by manual twisting or by a motor. Other shafts may be comprise plastics such as polyethylene, polyimide, or nylon and may have one or more lumens. Lumens carry electrical, optical or mechanical transmission lines, or cooling fluids. In the disclosed embodiment, the shaft 71 has a screw thread 79 at the distal end to facilitate attachment and detachment of the module 41 to the shaft 71. One possible use of the attachment thread may be to release the module 41 from the end of the shaft 71, once the module 41 is positioned inside a body, by unscrewing and releasing the module 41. The tubular shaft 71 may then slide over the small connector 73, which may be left outside the body. The module 41 may be re-connected to the shaft 71 before withdrawing the module 41 from the body.

On pages 12 and 13, please delete the paragraph bridging pages 12 and 13, and replace with the following paragraph:

Also etched from the substrate 91 is an avalanche photodiode (APD) array 121, which serves as a very sensitive light detector. In the embodiment shown in Figure 5, the light detector 121 has a two channel version. More channels, however, may be added by simply repeating the structure as follows: deposit Silicon oxide (SiO_2) layers 123 on N material layers 125, which are individually connected to posts 109 through fine wires 107. The depletion layer 127 is sandwiched between the N material layers 125 and the substrate 91, and may also serve as part of the common return circuit to post 110. A colored light filter 131 may be positioned over one or more of the light sensitive portions of the APD such that the spectral response of one channel is different from that of the other. In the disclosed embodiment, a colored light filter 131 is positioned over one channel. The filter, for example, may comprise a wave filter such as a dichroic

filter made of a glass, a grating, or a dye. The filter 131 may be temporarily positioned over a silicon oxide layer 123 and held in place while optical potting plastic 133 is molded over the assembly. Materials such as polystyrene, polycarbonate and methyl-methacrylate, for example, may be used as the optical potting plastic to cast or injection mold a desired shape of the package 90. Other materials such as urethanes may be used to form the cast as long as they are sufficiently transmissive of light energy and are reasonably elastic to allow small excursion such as the mirror 101. An air space around the gap 99 may be desirable depending on the index of refraction needed in the vicinity of the mirror 101 and the output end of the light emitting diode 93. One way to accomplish this is to place a premolded frame over the gap 99, which prevents the flow of potting material into that area. The frame may be injection molded out of the material also being used for the package 90 or a material that has a higher melting temperature. The frame may be bonded in place with a thin layer of clear epoxy film. The package 90 may be shaped to permit modification of the optical signals, which may enter or exit the package. In the embodiment shown, the serrated lens 135 is molded or embossed into the surface of the package 90. The advantage of this configuration is that a polished mold may be used to form a precision optical surface as desired. The state of the art injection molding techniques and relatively low viscosity thermoplastics such as polystyrene allow creation of very fine features with controllable dimensions and step heights on the surface. A dimension of the surface feature may be in the range of about 0.005 mm. Even finer features of less than 0.005 mm may be embossed using pressure and a photoetched master such that binary optical steps, holograms, or gratings capable of diffracting IR, visible, and UV light may be formed directly on the surface of the package 90. Creation of such features on the surface, or within the assembly, avoids the need for additional, expensive optical components and their holders. A conventional curved lens 137 is created on the surface of the package 90 to focus the light energy as desired. The conventional curved lens 137 also may be molded to the surface during the molding operation. A grating may

disperse light across the one or more detectors providing frequency selection capability.

In the Drawings:

A separate paper ("Amendment to Drawings") is submitted with this Amendment to correct certain defects in the drawings.

In the Claims:

Please cancel claims 21-38, without prejudice.

REMARKS

Applicant hereby amends the specification to provide information about related applications and to assert right of priority under 35 U.S.C. §§ 119 and 120. Applicant further amends the description to correct typographical errors. Amendments to drawings, submitted in a separate paper, include mere changes in the designations of figures and changes in reference numerals to agree with the Specification. Claims 1-38 are pending. Applicant hereby cancels claims 21-38, without prejudice. All amendments are supported by the original specification. No new matter is added.

Claims 1-20 are pending after the present Amendment and presented for consideration .

CONCLUSION

If the Examiner believes that a telephone conversation with Applicant's attorney would expedite allowance of this application, the Examiner is cordially invited to call the undersigned

attorney at (617) 248-7808.

Respectfully submitted,

Date: December 13, 2001

Duan Wu
(Limited Recognition under 37 CFR 10.9(b))
Attorney for Applicant

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WUD\1002\18.2202425_1

MARKED-UP COPY OF AMENDMENTS TO THE SPECIFICATION

➢ The section "Cross-Reference to Related Application" on page 1 is amended herein as follows:

Cross-Reference to Related Application

This application is a continuation of U.S. Patent Application Serial No. 09/478,774 filed January 6, 2001, which is a continuation application of U.S. Patent Application Serial 08/898,604 filed July 22, 1997, now U.S. Patent No. 6,119,031 which ~~This~~ is based on U.S. provisional patent application serial no. 60/033,334, filed November 21, 1996. The entire disclosure of these applications are incorporated herein by reference.

➢ The paragraph bridging pages 6 and 7 is amended herein as follows:

Referring now to FIG. 1B, the alternative signal processing system includes a centering scale meter 33 driven by a DC source 34 placed in the common return line 38 extending from the light detector ~~3~~85. This alternative signal processing system may be used to observe the different signal amplitudes of optical signals received by two or more channels of the light detector 5 operating simultaneously, or the normalized output of the light source versus the light energy received by the light detector 5. The amplitude of the reading may be used to determine the slope of the response signal relative to the input signal or to perform other more complex functions. It should be understood at this point that an equivalent operation may be obtained using a single channel light detector as long as a response property of the channel is varied over time. It may be possible to vary the response property by using, for example, one or more filters. In the case of a single channel light detector, the two signals may be obtained sequentially, if desired. The functions provided by the above-described circuitry may be achieved with other or additional electrical, mechanical, and/or optical apparatus without departing from the spirit and scope of the invention.

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frequencies of the light generated by the light source 3 while permitting passage of light output having a predetermined frequency. Light output permitted to pass through the filter is often in the ultraviolet range, and particularly has wavelengths from about 300 nm to about 400 nm. Such filters are generally available and known. Examples of these types of filters include tinted glass, sandwiched dyes, and interference filters otherwise known as dichroic filters. Alternatively, variable filtration may be employed by rotating the inner portion of the module 41 relative to portions of another colored material, such as a tinted plastic catheter sheath or a tip 81 shown in FIG. 4. The catheter sheath or the tip 81 may have differing filter characteristics owing to changes in thickness, or due to localized dyes.

➢ The paragraph bridging pages 9 and 10 is amended herein as follows:

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small diameter may be used as the shaft material. These shafts have relatively high lateral flexibility and good torsional stiffness, and can be positioned to specific angles by manual twisting or by a motor. Other shafts may be comprise plastics such as polyethylene, polyimide, or nylon and may have one or more lumens. Lumens carry electrical, optical or mechanical transmission lines, or cooling fluids. In the disclosed embodiment, the shaft 71 has a screw thread 79 at the distal end to facilitate attachment and detachment of the module 41 to the shaft 71. One possible use of the attachment thread may be to release the module 41 from the end of the shaft 71, once the module 41 is positioned inside a body, by unscrewing and releasing the module 41. The tubular shaft 71 may then slide over the small connector 73, which may be left outside the body. The module 41 may be re-connected to the shaft 71 before withdrawing the module 41 from the body.

- The paragraph bridging pages 12 and 13 is amended herein as follows:

Also etched from the substrate 91 is an avalanche photodiode (APD) array 121, which serves as a very sensitive light detector. In the embodiment shown in Figure 5, the light detector 121 has a two channel version. More channels, however, may be added by simply repeating the structure as follows: deposit Silicon oxide (SiO_2) layers 123 on N material layers 125, which are individually connected to posts 109 through fine wires 107. The depletion layer 127 is sandwiched between the N material layers 125 and the substrate 91, and may also serves as part of the common return circuit to post 110. A colored light filter 131 may be positioned over one or more of the light sensitive portions of the APD such that the spectral response of one channel is different from that of the other. In the disclosed embodiment, a colored light filter 131 is positioned over one channel. The filter, for example, may comprise a wave filter such as a dichroic filter made of a glass, a grating, or a dye. The filter 131 may be temporarily positioned over a silicon oxide layer 123 and held in place while optical potting

plastic 133 is molded over the assembly. Materials such as polystyrene, polycarbonate and methyl-methacrylate, for example, may be used as the optical potting plastic to cast or injection mold a desired shape of the package 90. Other materials such as urethanes may be used to form the cast as long as they are sufficiently transmissive of light energy and are reasonably elastic to allow small excursion such as the mirror 101. An air space around the gap 99 may be desirable depending on the index of refraction needed in the vicinity of the mirror 101 and the output end of the light emitting diode 93. One way to accomplish this is to place a premolded frame over the gap 99, which prevents the flow of potting material into that area. The frame may be injection molded out of the material also being used for the package 90 or a material that has a higher melting temperature. The frame may be bonded in place with a thin layer of clear epoxy film. The package 90 may be shaped to permit modification of the optical signals, which may enter or exit the package. In the embodiment shown, the serrated lens 135 is molded or embossed into the surface of the package 90. The advantage of this configuration is that a polished mold may be used to form a precision optical surface as desired. The state of the art injection molding techniques and relatively low viscosity thermoplastics such as polystyrene allow creation of very fine features with controllable dimensions and step heights on the surface. A dimension of the surface feature may be in the range of about 0.005 mm. Even finer features of less than 0.005 mm may be embossed using pressure and a photoetched master such that binary optical steps, holograms, or gratings capable of diffracting IR, visible, and UV light may be formed directly on the surface of the package 90. Creation of such features on the surface, or within the assembly, avoids the need for additional, expensive optical components and their holders. A conventional curved lens 137 is created on the surface of the package 90 to focus the light energy as desired. The conventional curved lens 137 also may be molded to the surface during the molding operation. A grating may disperse light across the one or more detectors providing frequency selection capability.

Express Mail Mailing Label No.: EL653444501US

PATENT
Attorney Docket No. BSC-010C2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT:	Crowley, R.		
SERIAL NO.:	Not yet assigned.	GROUP NO.:	Not yet assigned.
FILING DATE:	Herewith.	EXAMINER:	Not yet assigned.
TITLE:	MINIATURE SPECTROMETER		

Box PATENT APPLICATION
Assistant Commissioner for Patents
Washington, D.C. 20231

AMENDMENT TO DRAWINGS

Sir:

Submitted herewith are two sets of amended drawings, each comprising 5 sheets. One set is consisted of drawing sheets of Figures 1, 1a, 2, 2a, 3, 4 and 5 as originally filed in the parent application, with preliminary amendments marked in red. The other set is consisted of drawings amended as Figures 1A, 1B, 2A, 2B, 3, 4 and 5.

In The Drawings

In Figure 1, please delete "Figure 1" and insert --Figure 1A--.

In Figure 1a, please delete "1a" and insert --Figure 1B--.

In Figure 2, please delete "Figure 2" and insert --Figure 2B--, and delete reference numerals "5"; and insert line --2A--2A-- as indicated in red.

In Figure 2a, please delete "Figure 2a" and insert --Figure 2A--, delete reference numerals "5" and replace with reference numerals --61--.

In Figure 3, please insert reference numeral --70-- as indicated in red.

In Figure 4, please insert reference numerals --61--, --63--, --80--, --84--, and --86--, as indicated in red.

No amendment is presently requested for Figure 5.

REMARKS

Applicant hereby amends Figures 1, 1a, 2, 2a, 3, and 4. These amendments include mere changes in designation of figures and addition or changes in reference numerals to agree with the Specification. All amendments are supported by the application as originally filed, including, for example, pages 5, 8, 9, and 10 of the Specification.

Applicant submits that no new matter is added and respectfully requests that the proposed amendment to the drawings be considered and entered.

Respectfully submitted,

Date: December 13, 2001

Duan Wu
(Limited Recognition under 37 CFR 10.9(b))
Attorney for Applicant

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WUD\1002\18.2241487_1

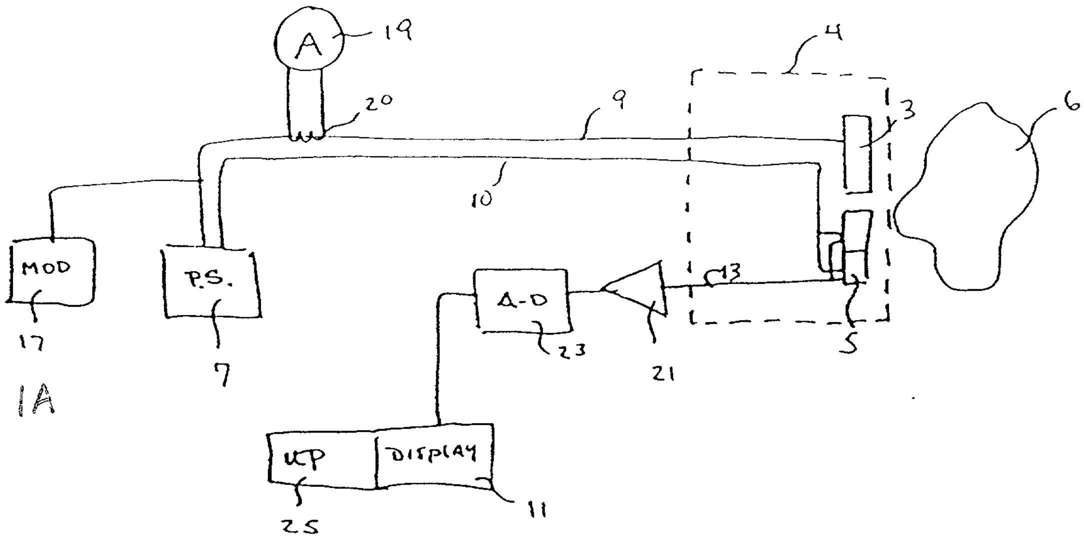

Figure 1A

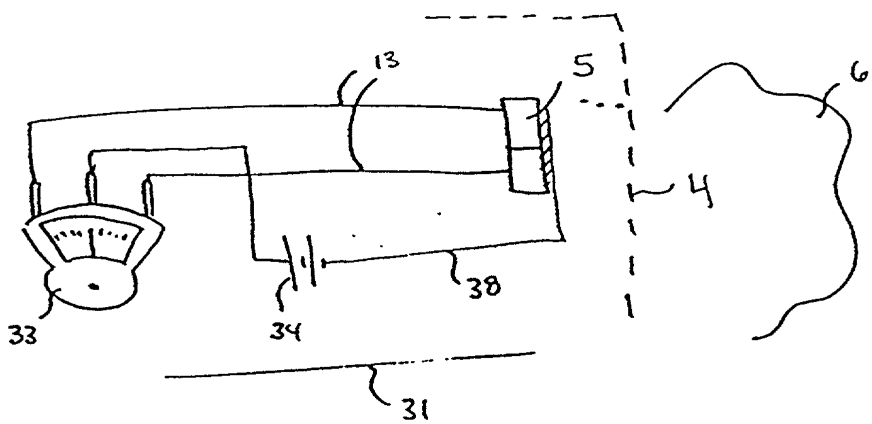

Figure 1B

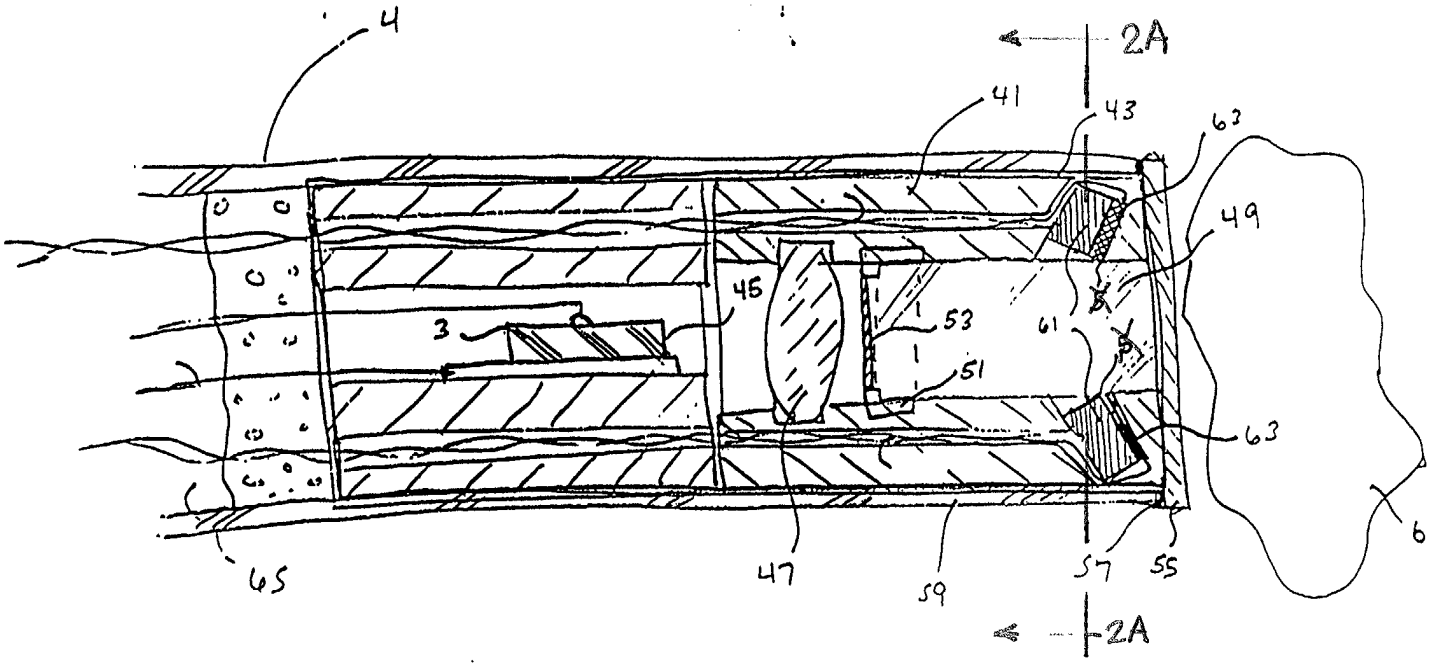

Figure 2B

~~Figure 2~~

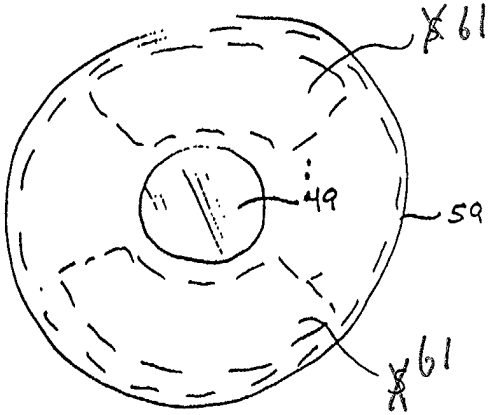

Figure 2A

~~Figure 2A~~

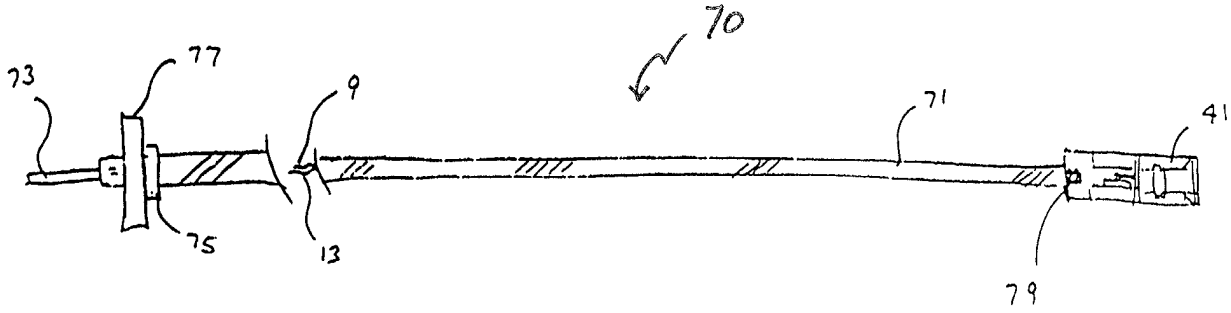

fig 3

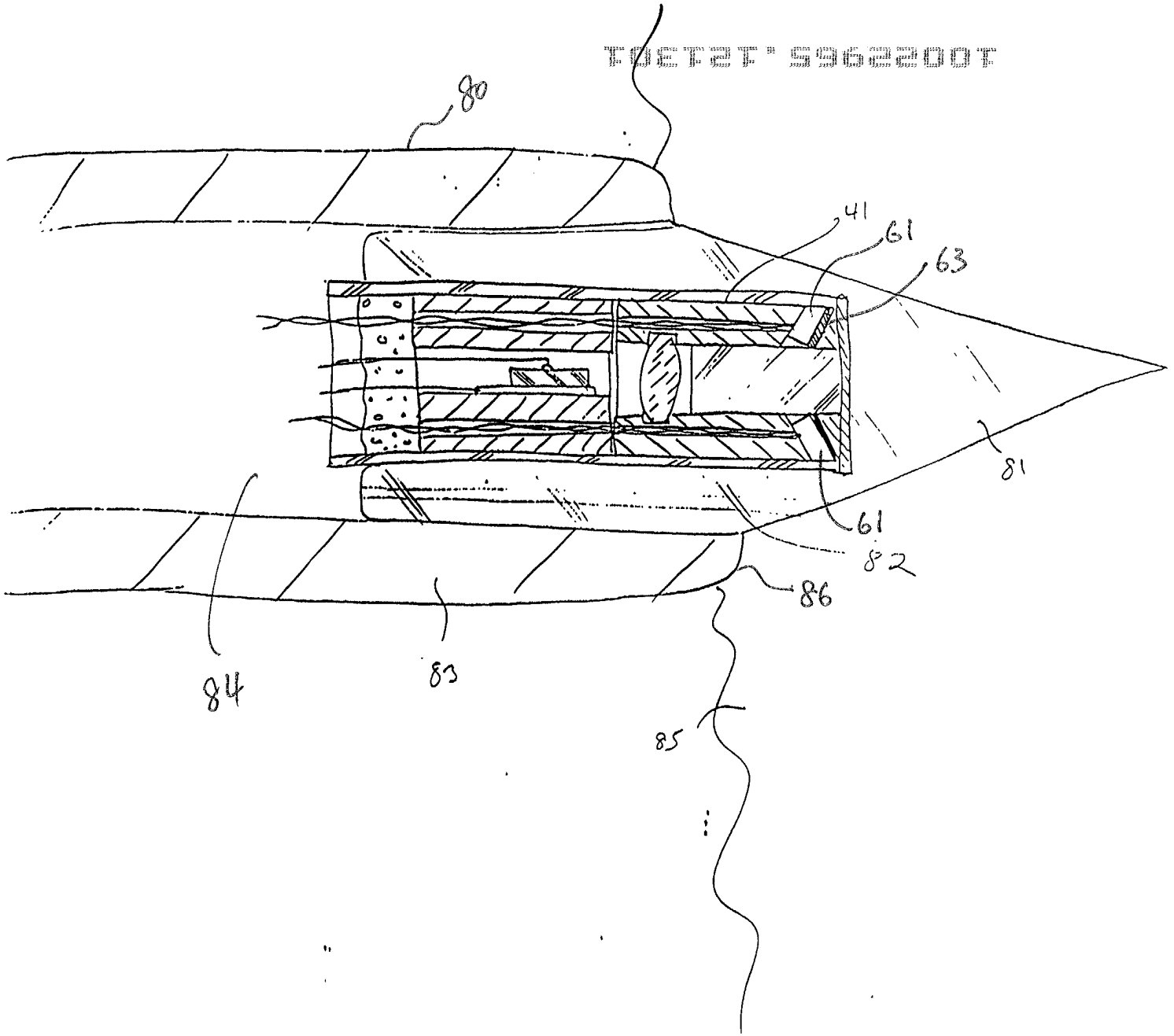

fig 4